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WIND ENERGY SCIENCE DISCUSSIONS

Interactive comment on "Wind farm layout optimization using pseudo-gradients" *by* Erik Quaeghebeur et al.

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The presented manuscript provides a computationally efficient method to perform wind farm layout optimization. The pseudo-gradients estimate the behavior of the design space to help find an improved wind farm layout using traditional gradient-based optimization methods.

I think the paper is very interesting and useful! Below are a list of questions/comments that I think would be helpful to clarify or consider.

1. In the overview of the pseudo-gradients (starting with section 3.1), it is not intuitive to me why you chose three pseudo-gradient definitions to apply to the waked turbine, and only one to the waking turbine. It seems like the three pseudo-gradients would

overdefine the downwind turbine and limit the upwind. Why not use two for each?

2. This may be related to the first question, so they may both be clarified in one step. When I first read through I understood (or maybe just assumed) that the pseudo-gradients would be combined to determine the step size and direction during optimization. However, when reading through the results it seemed like you chose the one pseudo-gradient type that achieved the best gain, and only took a step according to that pseudo-gradient. Which is correct? If you do only use one pseudo-gradient to determine the step, why not combine them to achieve better/faster convergence?

3. Not an issue, more a curiosity that other people might have as well. Have you considered including the constraint information in the pseudo-gradients as well, as to not need to force feasible solutions and potentially gain more exploration?

4. Reading through the manuscript, my impression is that the objective function really doesn't matter that much, as the pseudo-gradient direction is determined spatially and the step size is not really the true gradient. Have you tried a similar method with just spatial information? You would just need one or two tuning parameters that would be used to determine step size as a function of distance, but you wouldn't need a wake model. Has this been explored at all? (note, I don't necessarily think this needs to be fully explored or resolved for this publication, but I do think others might have a similar question so it might be worth addressing in the text)

5. The magnitude of the cross-stream pseudo-gradient seems arbitrary. Using a projection of one of the other pseudo-gradients (if I understood correctly) means the magnitude would always be relatively small. Often though the cross-stream gradients would be much higher than the stream wise ones (moving side to side gives much faster gains than moving further apart). It seems your formulation prioritizes that opposite. Can you explain or justify this?

6. It seems like a main outcome of this work is to be able to quickly and efficiently perform wind farm layout optimization that finds an improved layout, but much faster than

other methods. However, you haven't provided any of that comparison. You probably don't need it for everything, but for one or two of the cases can you provide comparisons of optimizer performance and computational expense with some other methods? It seems like from a performance perspective, optimizing with exact analytic gradients would be just as fast as your proposed method, and achieve a better result. That would certainly not discount using pseudo-gradients to perform layout optimization, as often exact analytic gradients are difficult and time consuming to derive, but it would help frame it better.

A few small notes

- I recommend changing the bullets on page 3 (lines 25-30). They look like minus signs.

- Page 7 line 6: should be "this value is the same for all turbines"?

- Page 7 line 17: clarify that they are equivalent because you assume a fixed number of turbines.

- Page 8 line 1: "away" and "back" were initially unclear to me. It would be helpful to clarify, maybe with relative terms? "Further downstream" and "further upstream" could potentially work.

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